Journal of Engineering and Technology

ISSN 2180-3811 eISSN 2289-814X https://journal.utem.edu.my/index.php/jet/index

DESIGN OF WIRELESS SENSOR NETWORK FOR MONITORING INTENSIVE HEALTH CARE ROOM

I. S. Mohammed[1], L. A. Al-Siddiq[1], S. I. Abdullah[1], K. A. Ahmed[1] and M. M. Abdulwahab*[2]

[1] Al Nour College of Science and Technology.

[2] Department of Electronics Engineering, University of Gezira, Sudan.

corresponding_ murtadaabdelwahab@gmail.com

Article history:
Received Date: 3 July 2021
Revised Date: 5 March 2022
Accepted Date: 29 June 2022

Keywords:
Electronics Design, Sensors, Wireless System, XBee, Programming, Arduino.

Abstract— Wireless monitoring systems are promise technologies which are used in different fields such as industry, agriculture and medical fields. Chronic diseases have been recently increased dramatically in all over the world. Thus, an effective health monitoring system (HMS) became required to provide good service system able to cover the crowded of patients. Wireless monitoring system became very useful technique for some diseases such as COVID-19, which reduce the spread of the virus and protect the medical staff. This paper presented a design of wireless monitoring system based on Arduino controller. The design aimed to give high quality and quick service in critical stages with advanced medical facilities. The design was simulated and tested in different operation cases. The proposed HMS

system provides real time monitoring of patient health parameters such as blood pressure, heart rate, blood planning and blood sugar. The proposed design consists of four medical devices connected to work together simultaneously, and the device displayed the patient situation continuously. The received measurements of the sensors transmitted wirelessly via XBee module to an interface page which designed using visual basic language to provide central monitoring of all the patients rooms. The obtained results investigated the operating cases to prove the reliability of the system and all achieved results were corrected.

I. Introduction

Wireless monitoring system provides efficient protecting of the medical staff such as doctors from some diseases such as COVID-19 due to keeping them away from the patient. Wireless sensor networks give the ability to observe the measuring value of physical quantity in a specific environment wirelessly [1][2]. Recently the wireless sensor networks (WSN) were used widely in different applications fields such as telemedicine, industry and weather monitoring. The use of WSN in the medical field assists to provide an efficient monitoring of patients via wireless network [2][3]. In some medical cases, the patient needs different types of monitoring care due to many factors such as chronic diseases, as well as critical medical cases that require 24 hours of monitoring. This paper works in this direction and applied the principle of WSN in a clinical observation design to provide high quality of health care service. The heart health can be recognized using a record of its electrical activity [4]. Cardiac

cycle refers to duration of the heartbeat which considered an important factor that required to be observed [5][6][7]. This paper aimed to provide a design of wireless monitoring system to observe the heart rate, blood glucose, temperature and the pressure continuously. The system combined all those parameters in single equipment and provides easy used because it includes monitoring page connected wirelessly to the hardware. The monitoring page enables the doctors to monitor many patients in real time, therefore it helps to solve the problem of the lack in the medical staff also it protects them from the infection. The system assists doctor or nurse to monitor the patient's condition from a distance. The wireless monitoring technology reduces the human errors, save time and lives. It gives real time monitoring and contains digital display [8]. There are many publications of health care systems because it is an attractive research field. The essential difference of our proposed design and other designs is assembling four medical devices in single equipment also this design offers an interface monitoring page divided to different units for each room. Also the communication technique is differed from some of the papers used GSM but in this works we used XBee technology because the design aimed to be used in the short range in the hospital to monitor all the rooms of patients wirelessly. All patient rooms are connected to a central control room to monitor patients across the hospital, and doctors are notified in the event of something happening on loudspeakers placed in the hospital, therefore, avoids the problems of not existing GSM service. The bandwidth required for Bluetooth is low, while it is high for Wi-Fi. In Kamal et al [9] home monitoring system was developed but it not used for critical cases, it used GSM technology to send SMS massage if a critical case happened. The system used to monitor pressure, temperature and heart beats. Abdullah et. al. [10] designed mobile wireless

health care system can be used to monitor patients and send SMS alarm massage and e-mail massage. The system based on Arduino and design by using Lab View software. The system in Majumder et al [11] used android and Bluetooth technology, the system aimed to provide monitoring health care system. Bhera et al [12] presented wireless system of monitoring temperature body via radio frequency (RF) technology, the results are shown in LCD screen The major components of the system on microcontroller and temperature sensor.

The proposed system designed for internal monitoring of intensive care room therefore it is not required long distance transmitting device. We have used the XBee short-range wireless device on the hospital scale so that the data is sent quickly without problems in transmission and reception, and the doctors are notified quickly to ambulance the patient in case his health condition deteriorates because in Sudan there are problems in the GSM, SMS, and Wi-Fi network on a long-range range to avoid bad network and malfunctions.

II. Methodology

In this design of a group of medical devices that measure temperature, blood pressure, glucose meter and ECG were assembled in single device and simulated using Proteus design suite. The basic specifications of the circuit as shown in Figure 1, which consists of the following:

- Temperature sensor (LM35)
- Arduino UNO R3
- Pot-HT
- Heart-Rate (MAX 30102)
- Photoplethysmogram and blood pressure-Sensor (MAX 86150)
- virtual terminal
- oscillator
- XBee
- COMPIM

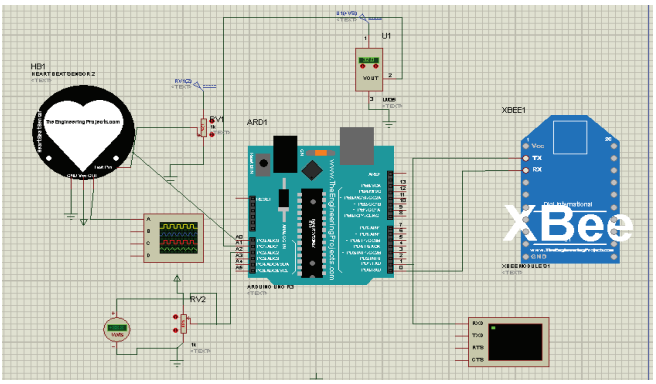

Figure 1: Transmitter Circuit

Three types of sensors were used temperature, heartbeat, pressure; the blood glucose sensor was simulated by using a variable resistance whose value is manually controlled to know the level of sugar in the blood. These group of sensors connected to Arduino microcontroller to process the information and transmitted it to the monitoring page through XBee. The receiver circuit is shown in Figure 2. It consists of XBee module which connected to COMP module to display the receive data in the monitoring page. The COMP module is a virtual serial port used in the proteus software to receive serial communication via computer [13]. The XBee operate with the IEEE 802.15.4-2003 standard. It used RF communication support the point-to-point and the star communications [14].

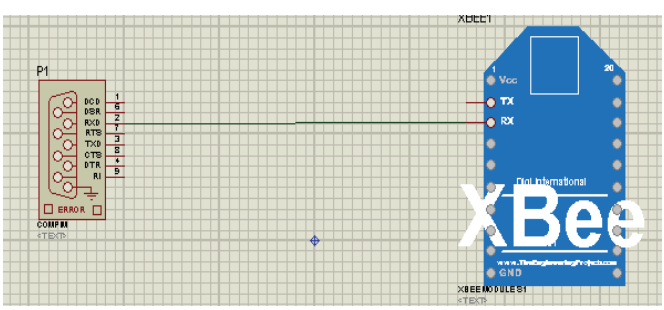

Figure 2: Receiver Circuit

The basic block diagram of the system is shown in Figure 3. The device is connected from a power source, and a microcontroller is connected to it, and the sensor is connected to a microcontroller to activate the sensor data collection process. The data collected will be sent to a monitoring page in a central control room in the name of the hospital, and the data will be displayed continuously in digital form.

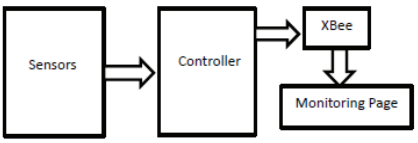

Figure 3: Block Diagram

A. Temperature Monitoring System

The flow chart of temperature monitor system is shown in Figure 4. The temperature sensor provides real time reads and then determines the state of the loop. If the temperature is normal, 37°C, the data is displayed on the monitor screen. Then the measurement is repeated again whether the temperature is high or low, the measurements are displayed in the monitor screen and it takes the measurement again and then displays it.

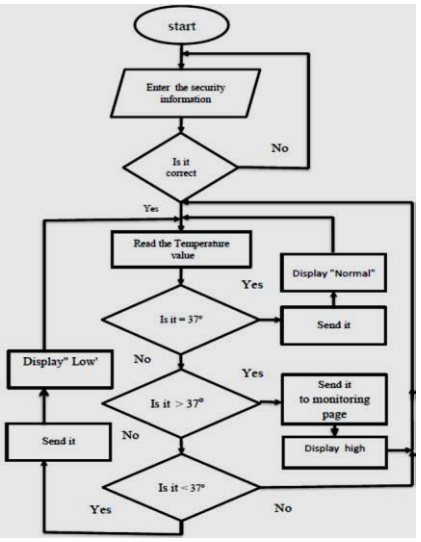

Figure 4: Temperature Flowchart

B. Blood Pressure Monitoring System

The flow chart of blood monitoring system is shown in Figure 5. The blood pressure sensor reads pressure into the decision or status loop.

If the pulses were in the rate of 60 to 100, then they are normal, the data is displayed on the monitor. Either if the height of the pulse is more than 100 or less than 60, the measurements will be displayed in the screen to alert the person in charge of the

screen and then the measurement is repeated again continuously.

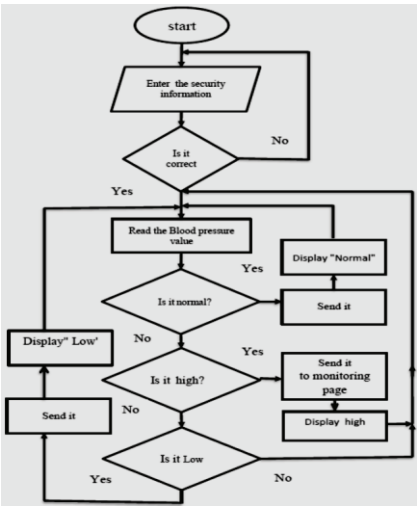

Figure 5: Blood Pressure Flowchart

C. Blood Glucose Monitoring System

The flow chart of blood glucose system is shown in Figure 6. The blood glucose sensor reads the level of glucose in the blood continuously. If the glucose level is in the range of 90 to 120, then it is in the normal level, the data is displayed on the monitoring screen. In the case of low level glucose (less than 90) the reading value is displayed on the screen to alert the doctor. Also when the glucose level became higher than 120 the glucose value appeared on the doctor monitoring page.

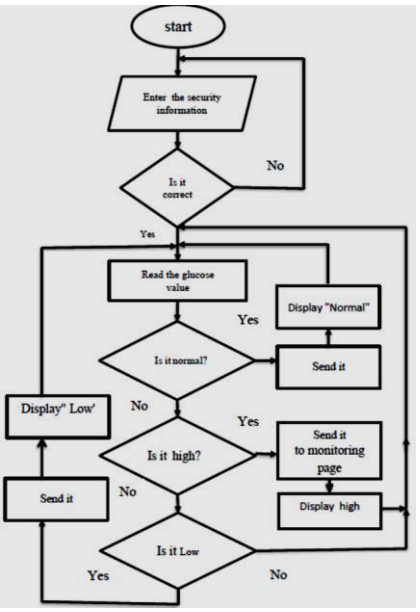

Figure 6: Blood Glucose Flowchart

III. Monitoring System

This part of the paper shows the significant of the proposed design. The monitoring page which used by the user on the receiver side used to display the patient information wirelessly. The receiver circuit consists of a main screen with a username and password, this page was designed with a program visual studio. The first step in using this system is to enter the correct username and password as shown in Figure 7.

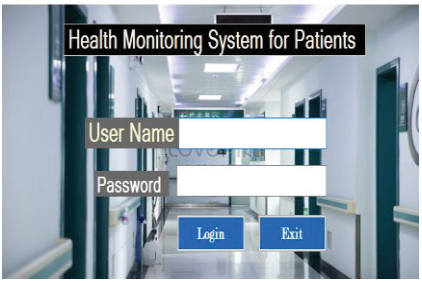

Figure 7: User Information

Once the user of the page entered the user name and password and the system matching them with the correct data, a success message will be sent to enter and transfer the user to the next screen as shown in Figure 8.

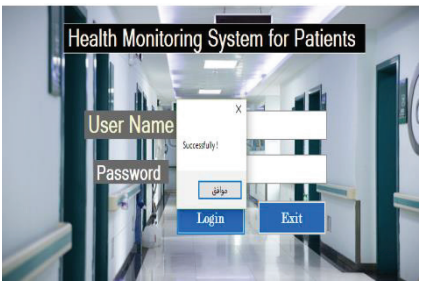

Figure 8: Successful User Information

If the entered security information were incorrect as shown in Figure 9, then an error massage is appeared in the main page.

The main screen for monitoring patient information is shown in Figure 10. It appears directly after login correctly and it includes a connection button and a tab for monitoring.

Figure 9: Incorrect user

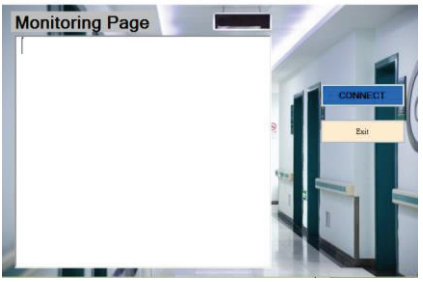

Figure 10: Monitoring Page

IV. Results and Discussions

The results were shown in the virtual screen and the monitoring screen, the simulation results tested the four parameters in the normal case and in other situation high or low. The results in the normal case of blood pressure, blood sugar, body temperature, and heart rate are shown in the virtual screen as shown in Figure 11.

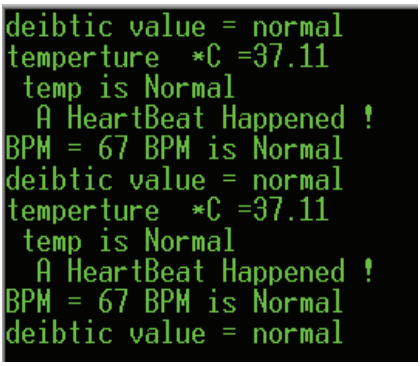

Figure 11: Normal Reading

As shown in Figure 12 the default screen displayed high level for all the sensors. The results include the four parameters and this simulation test aimed to observe the response of the system when all the sensors were set in high range.

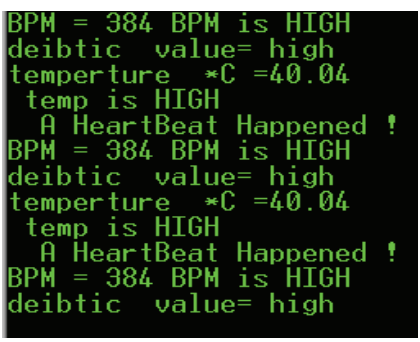

Figure 12: High Levels of all sensors

Figure 13 illustrated the default screen that displays the results when sensors reads low levels. The results include the four parameters and this simulation test was done to observe the response of the system when all the sensors were set in low range.

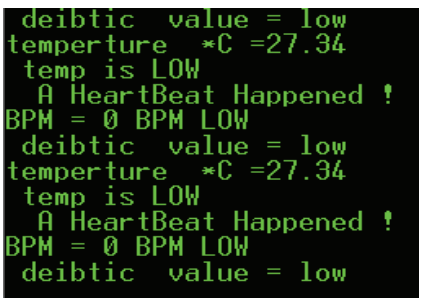

Figure 13: Low Levels of all sensors

If there is a rise or fall in one of the measurements, it will be appeared directly on the monitoring screen. Figure 14 shows an example of a patient results in room 1, when the measuring results of blood and temperature were normal while heart beat has a problem.

Similarly, Figure.15 illustrates the results on the monitoring page when a patient in room 2 has a heart problem in addition to high level of blood sugar, in this case all the sensors measured high level.

Finally; Figure 16 shows the results of a patient in room 3, in this case all the sensors

measured low level and displayed digitally in the monitoring screen.

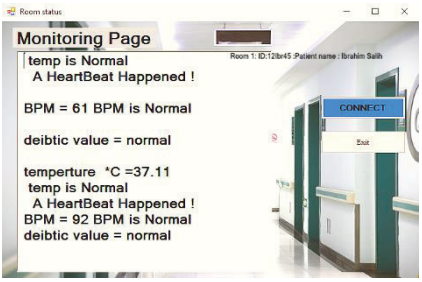

Figure 14: Normal Case

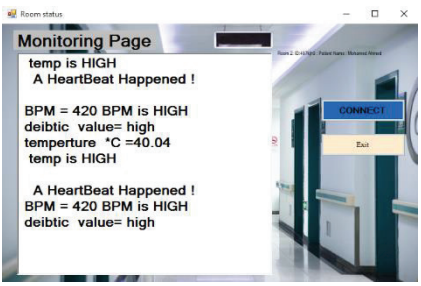

Figure 15: High Reading Results

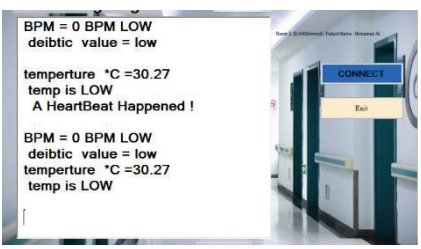

Figure 16: Low Reading Results

The overall results proved that the system provided an accurate result because when it was tested for several cases, different patients and rooms. The results were appeared directly the monitoring page and illustrates the patient room in addition to the diagnosis of the patient.

V. Conclusion

This paper developed a wireless monitoring system that aims to provide a real-time wireless monitoring system for some medical standards, and an ECG. The simulation results prove that the to detect and predict a heart attack. The observer will be alerted in the display screen when the body temperature and heart rate blood pressure and blood glucose exceed and or fall below the set threshold level. This goal is achieved by measuring heart rate, body temperature; blood sugar level and the system is useful when continuous monitoring is required under critical conditions. In addition, it is a very usable device due to its portability which means that patients can carry it, thus there is no need to stay in hospitals as the monitoring device is applicable almost everywhere.

VI. Acknowledgement

This works was done under supervision for Al Nour College of Science and Technology.

VII. References

[1] K. Sohrabyn, D. Minoli, T. Znati, *Wireless sensor networks: technology, protocols, and applications*. John Wiley & Sons, 2007.

[2] S. M. Kerner, *Wireless* (2021) [Online] Available: https://searchmobilecomputing.techtarget.com/definition/wireless

[3] J. Smith and R. Roberts, *Vital Signs for Nurses: An Introduction to Clinical Observations*. Wiley-Blackwell, 2011.

[4] R. Biswarup, *Analysis of PPG and ECG*. LAP Lambert Academic Publishing, 2015.

[5] J. E. Hall, *Guyton and Hall Text Book of medical physiology*. Elsevier - Health Sciences Division, (13th ed.), 2015.

[6] *Medical Instrumentations* (2016). [Online] Available: http://www.webmed.com

[7] *American Heart Association* (2016). [Online] Available: http://ww.heart.org

[8] *Sudanese Association for Heart Diseases* (2017). [Online] Available: http://ww.heart.org

[9] M. K. M. Mokhtar, "Design of wireless patient health monitoring system," Sudan University of Since and Technology, Master Thesis, 2015.

[10] A. Abdullah, A. Ismael, A. Rashid, A. Abou-ElNour, and M. Tarique, "Real Time Wireless Health Monitoring Application Using Mobile Devices," *International Journal of computer Networks & Communications*, vol. 7, no. 3, pp. 13-30, 2015.

[11] S. Majumder, M. A. Rahman, M. S. Islam and D. Ghosh, "Design and Implementation of a Wireless Health Monitoring System for Remotely Located Patients," ", *4th International Conference on Electrical Engineering and Information & Communication Technology (iCEEiCT)*, pp. 86-91, 2018. doi: 10.1109/CEEICT.2018.8628077

[12] S. K. Bhera, S. S. M. Choudhary, L. K. Sharma and R. Singh, "Automatic Wireless Health Monitoring System in Hospital," *International Journal for Science Research & Development*, vol. 5, no. 1, pp. 1017-1019, 2017.

[13] 2019. [Online] Available: https://www.virtual-serial-port.org/article/com-port-in-proteus

[14] 2019. [Online] Available: https://en.wikipedia.org/wiki/XBee